ISR/VA/CB/sm

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ISR PERFORMANCE REPORT

# Operation of the Cold Bore with adsorbed helium

Run 1142 MD, 18th July 1980

## Introduction

The presence of large quantities of liquid helium around the vacuum chamber of a machine equipped with superconducting magnets may result in helium leaks which are otherwise negligible because of the very low helium content of normal air.

Existing experimental data[1)] on the yield of desorption of He by ions of 1 keV energy show that values about equal to those of $H_2$ may be obtained for coverages of about $10^{15}$ molecules/cm$^2$, or 0.3 of a monolayer. For $H_2$ coverages larger than 3 monolayers, as during our experiment with $H_2$ (R 936), the desorption yield is about 10 times higher.

On the other hand, the sticking factor, which defines the pumping speed, is for submonolayer coverages of He about 6 times lower than for condensed $H_2$ (0.15 instead of 0.9, see ref. 1).

Consequently, an equilibrium situation between desorption and pumping similar to that previously experienced with $H_2$ should be obtained for an He coverage of about $10^{15}$ molecules/cm$^2$.

In the present Cold Bore configuration the desorption of He atoms by infrared radiation entering from the extremities of the cryostat is not negligible with respect to the thermal desorption. A previous test, carried out without proton beam during a machine shutdown, showed that about 0.35 of an He monolayer may be adsorbed resulting in a radiation induced stable pressure not higher than 2 x $10^{-10}$ torr ($N_2$ equivalent). Thermal desorption was made negligible by cooling the Cold Bore to 2.9 K (He bath at a pressure of 150 torr). This He quantity was chosen for the present experiment. A higher static pressure might produce helium contamination of the ISR outside the Cold Bore sector and would also result in an appreciable decrease of He coverage by external pumping during the experiment.

## The experiment

The cryostat was remotely filled with liquid He before the beginning of the MD run. At 9 h, during the controlled access to the ISR tunnel, the helium transfer line was removed, the pressure on the He bath reduced by pumping to about 500 torr, the diaphragms on the two nearest pumping stations closed and He injected. Injection was carried out at a pressure of 8 x $10^{-8}$ torr ($N_2$ equivalent) for a period of 13 minutes. For defining the injected quantity of He it was assumed that the pumping speed of the cryostat is infinitely large when compared to the conductance of the vacuum chamber between the cryostat and the point where the injection pressure is measured. The sensitivity of the ISR pressure gauges for He is 0.2 of that for $N_2$. The total quantity injected, under this assumption, was 0.35 of a monolayer or about $10^{15}$ molecules/cm$^2$.

After injection, the temperature of the cryostat was raised to 4.6 K (about 1050 torr on the helium bath) to obtain a uniform coverage along the cold tube. The achievement of uniformity was guaranteed by equal pressure readings on the two sides of the cryostat. Finally, the temperature of the Cold Bore was reduced to 2.9 K to reduce the He static pressure to below 2 x $10^{-10}$ torr. Upon achieving this pressure at 12.35 h, the sector valves were opened and machine set-up started.

The behaviour of the pressure as seen by the gauges 317.3 (injection side) and 317.6 (opposite side) is shown in figs. 1 and 2. On both sides increasing the beam current up to a maximum of 40.6 A resulted in a small and similar pressure rise. Upon scraping the beam in two steps to 32 A, a similar pressure decrease was noticed. Scraping was made necessary by an important pressure rise in 241. The beam was dumped at about 21.45 h because when pumping on the helium bath the lifetime of a cryostat filling is only about 12 hours. Dumping the beam produced a noticeable pressure decrease on both gauges (about 1 x $10^{-11}$ torr at a pressure one order of magnitude higher).

## Discussion and conclusions

The behaviour of adsorbed He closely approaches, as expected, that of condensed $H_2$ observed during the run 963 (see ISR-VA/CB/sm of 1st June 1978). In both cases increasing the proton beam current resulted in small but noticeable pressure rises and in both cases dumping a beam of about 30 A produced a similar pressure decrease.

More precisely, the measured pressure decrease in the case of $H_2$ was 15%. According to the arguments developed in the introduction a pressure decrease of 9% was expected for He. The corresponding measured value was 10%. Also, in the present experiment the maximum intensity of the beam current was much below the critical value. Therefore, it appears that any possible perturbation deriving from He entering the vacuum chamber of a Cold Bore machine would be mainly due to the increase of the static pressure rather than to ion induced desorption. In this respect, it should be recalled that the pumping speed for He of a metal surface at liquid He temperatures dramatically decreases when a approaching the monolayer coverage. This would result in a large increase of the static pressure even if the thermal radiation load is smaller than in the present situation.

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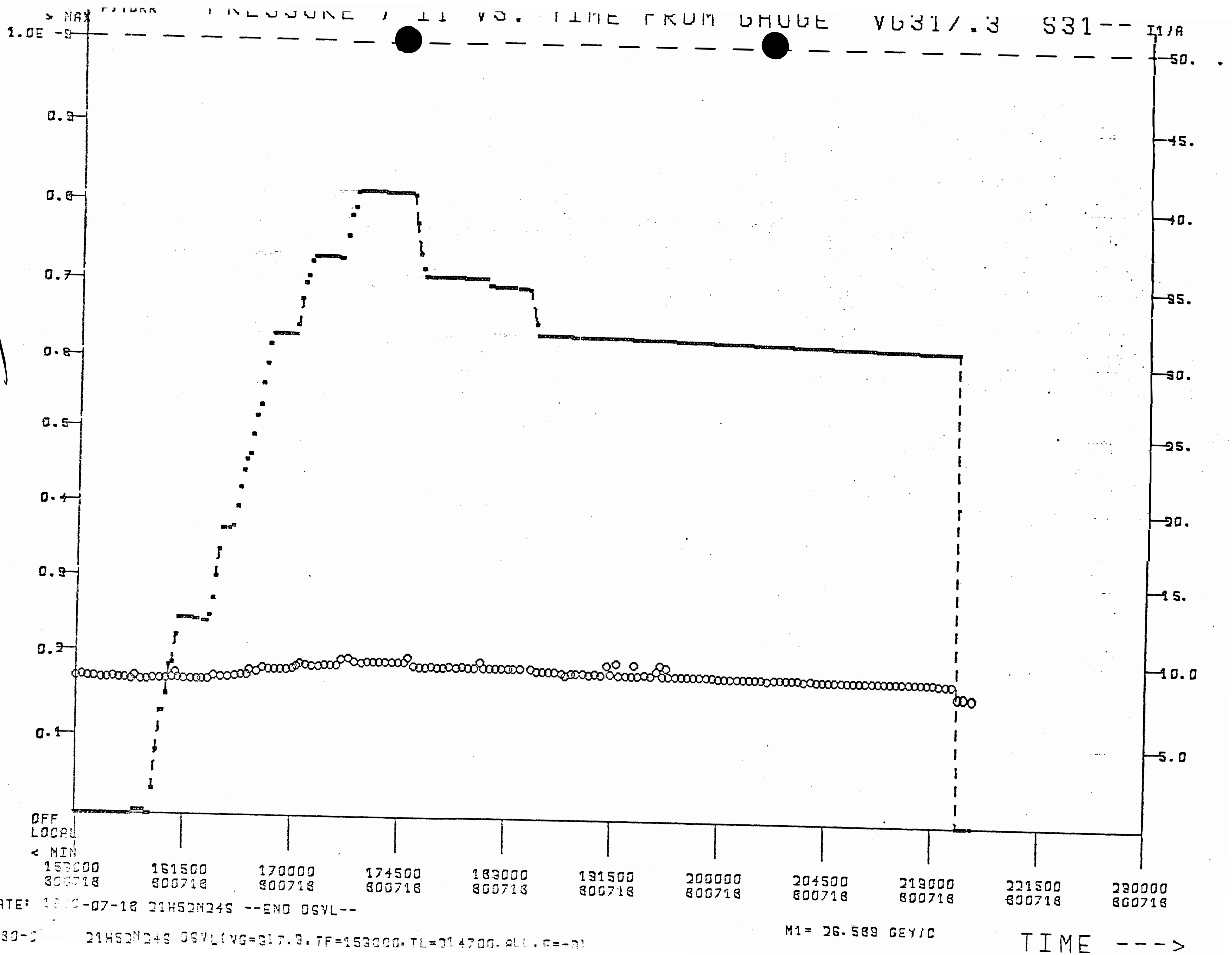
## References

1. N. Hilleret, unpublished measurements.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0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
OFF
LOCAL
< MIN
I1/A
50.
45.
40.
35.
30.
25.
20.
15.
10.0
5.0
161500 800718
170000 800718
174500 800718
183000 800718
191500 800718
200000 800718
204500 800718
213000 800718
221500 800718
230000 800718
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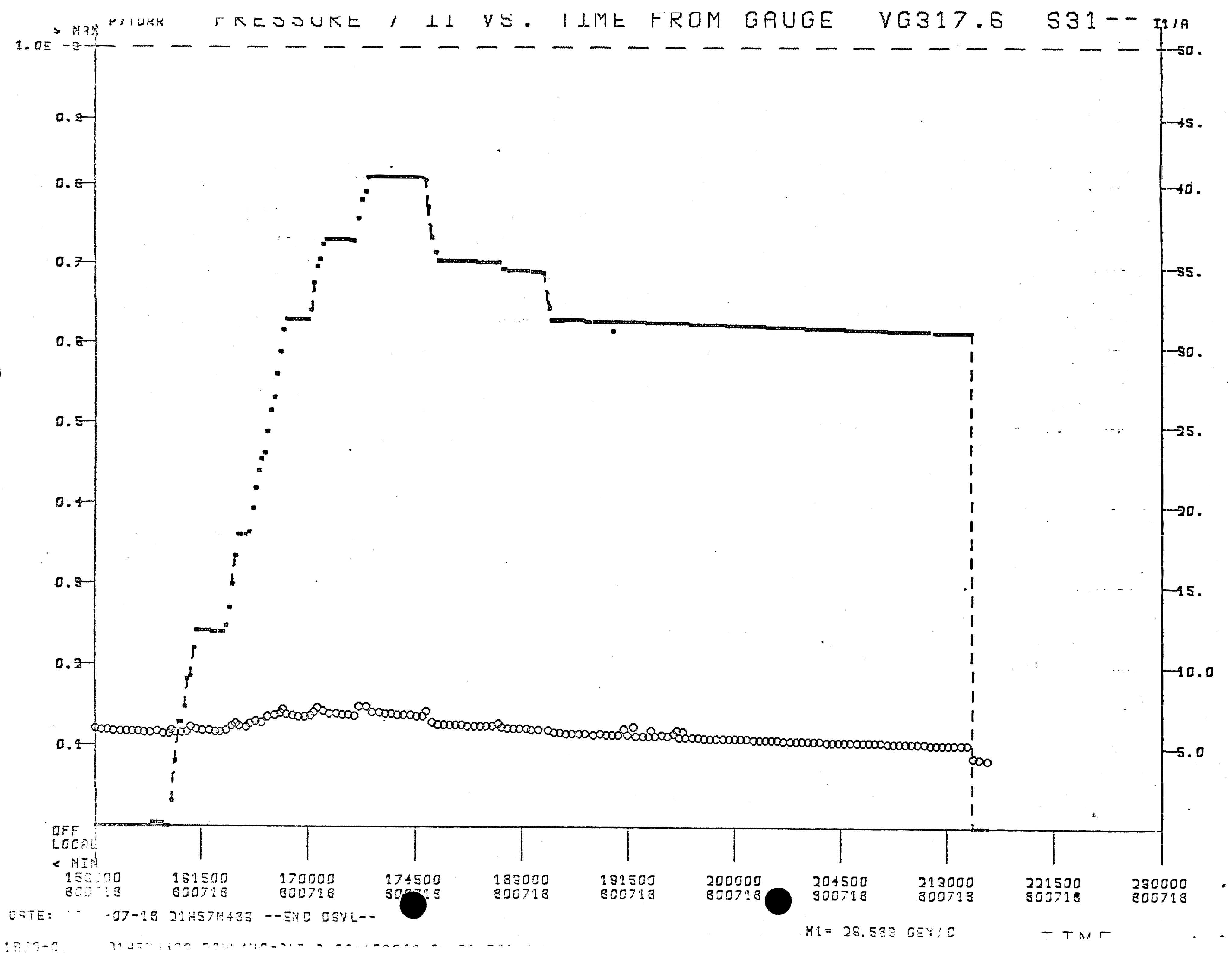
TIME --->


Figure 1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0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
50.
45.
40.
35.
30.
25.
20.
15.
10.0
5.0
OFF
LOCAL
< MIN
161500 800718
170000 800718
183000 800718
191500 800718
200000 800718
204500 800718
213000 800718
221500 800718
230000 800718
DATE:
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Figure 2